CD4051B-Q1, CD4052B-Q1, CD4053B-Q1
CMOS ANALOG MULTIPLEXERS/DEMULTIPLEXERS WITH LOGIC–LEVEL CONVERSION

SCHS354 – AUGUST 2004

Features

- Qualification in Accordance With AEC-Q100†
- Qualified for Automotive Applications
- Customer-Specific Configuration Control Can Be Supported Along With Major-Change Approval
- Wide Range of Digital and Analog Signal Levels
  - Digital: 3 V to 20 V
  - Analog: ≤ 20 V_{P-P}
- Low ON Resistance, 125 Ω (Typ) Over 15 V_{P-P} Signal Input Range for $V_{DD} - V_{EE}$ = 18 V
- High OFF Resistance, Channel Leakage of ±100 pA (Typ) at $V_{DD} - V_{EE}$ = 18 V
- Logic-Level Conversion for Digital Addressing Signals of 3 V to 20 V ($V_{DD} - V_{SS}$ = 3 V to 20 V) to Switch Analog Signals to 20 V_{P-P} ($V_{DD} - V_{EE}$ = 20 V)
- Matched Switching Characteristics, r_{on} = 5 Ω (Typ) for $V_{DD} - V_{EE}$ = 15 V
- Very Low Quiescent Power Dissipation Under All Digital-Control Input and Supply Conditions, 0.2 μW (Typ) at $V_{DD} - V_{SS} = V_{DD} - V_{EE}$ = 10 V
- Binary Address Decoding on Chip
- 5-V, 10-V, and 15-V Parametric Ratings
- 100% Tested for Quiescent Current at 20 V
- Maximum Input Current of 1μA at 18 V Over Full Package Temperature Range, 100 nA at 18 V and 25°C
- Break-Before-Make Switching Eliminates Channel Overlap

† Contact factory for details. Q100 qualification data available on request.

Applications

- Analog and Digital Multiplexing and Demultiplexing
- Analog-to-Digital (A/D) and Digital-to-Analog (D/A) Conversion
- Signal Gating

description/ordering information

The CD4051B, CD4052B, and CD4053B analog multiplexers are digitally-controlled analog switches that have low ON impedance and very low OFF leakage current. Control of analog signals up to 20 V_{P-P} can be achieved by digital signal amplitudes of 4.5 V to 20 V (If $V_{DD} - V_{SS}$ = 3 V, a $V_{DD} - V_{EE}$ of up to 13 V can be controlled; for $V_{DD} - V_{EE}$ level differences above 13 V, a $V_{DD} - V_{SS}$ of at least 4.5 V is required). For example, if V_{DD} = 4.5 V, V_{SS} = 0 V, and V_{EE} = −13.5 V, analog signals from −13.5 V to 4.5 V can be controlled by digital inputs of 0 V to 5 V. These multiplexer circuits dissipate extremely low quiescent power over the full $V_{DD} - V_{SS}$ and $V_{DD} - V_{EE}$ supply-voltage ranges, independent of the logic state of the control signals. When a logic high (H) is present at the inhibit (INH) input, all channels are off.

ORDERING INFORMATION

T_A	PACKAGE‡		ORDERABLE PART NUMBER	TOP-SIDE MARKING
−40°C to 125°C	SOIC – M	Reel of 2500	CD4051BQM96Q1	CD4051Q
	TSSOP – PW	Reel of 2000	CD4051BQPWRQ1	CM051BQ
	SOIC – M	Reel of 2500	CD4052BQM96Q1§	CD4052Q
	TSSOP – PW	Reel of 2000	CD4052BQPWRQ1§	CD4052Q
	SOIC – M	Reel of 2500	CD4053BQM96Q1	CD4053Q
	TSSOP – PW	Reel of 2000	CD4053BQPWRQ1§	CD4053Q

‡ Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

§ Product Preview

description/ordering information (continued)

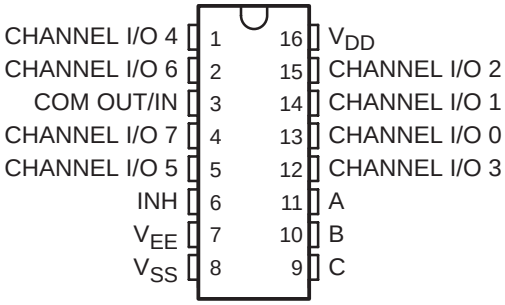
The CD4051B is a single eight-channel multiplexer that has three binary control inputs (A, B, and C) and an inhibit input. The three binary signals select one of eight channels to be turned on and connect one of the eight inputs to the output.

The CD4052B is a differential four-channel multiplexer that has two binary control inputs (A and B) and an inhibit input. The two binary input signals select one of four pairs of channels to be turned on and connect the analog inputs to the outputs.

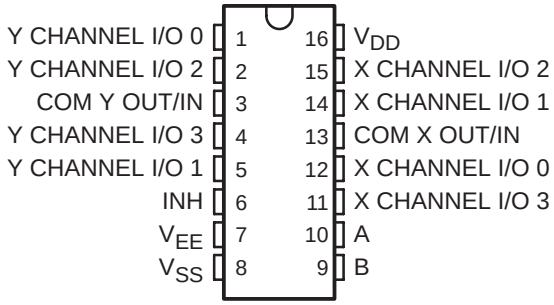
The CD4053B is a triple two-channel multiplexer with three separate digital control inputs (A, B, and C) and an inhibit input. Each control input selects one of a pair of channels, which are connected in a single-pole, double-throw configuration.

When these devices are used as demultiplexers, the CHANNEL IN/OUT terminals are the outputs, and the common (COM OUT/IN) terminals are the inputs.

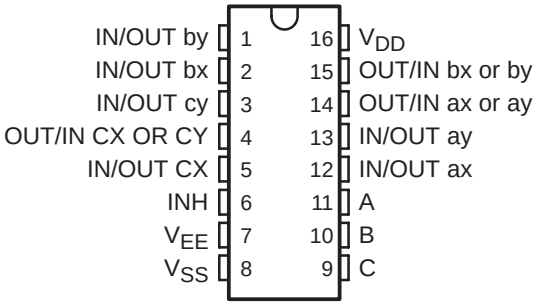
CD4051
M OR PW PACKAGE
(TOP VIEW)



CD4052
M OR PW PACKAGE
(TOP VIEW)



CD4053
M OR PW PACKAGE
(TOP VIEW)



Function Tables

CD4051

INPUTS				ON CHANNEL
INH	C	B	A	
L	L	L	L	0
L	L	L	H	1
L	L	H	L	2
L	L	H	H	3
L	H	L	L	4
L	H	L	H	5
L	H	H	L	6
L	H	H	H	7
H	X	X	X	None

X = don’t care

CD4052

INPUTS			ON CHANNEL
INH	B	A	
L	L	L	0x, 0y
L	L	H	1x, 2y
L	H	L	2x, 2y
L	H	H	3x, 3y
H	X	X	None

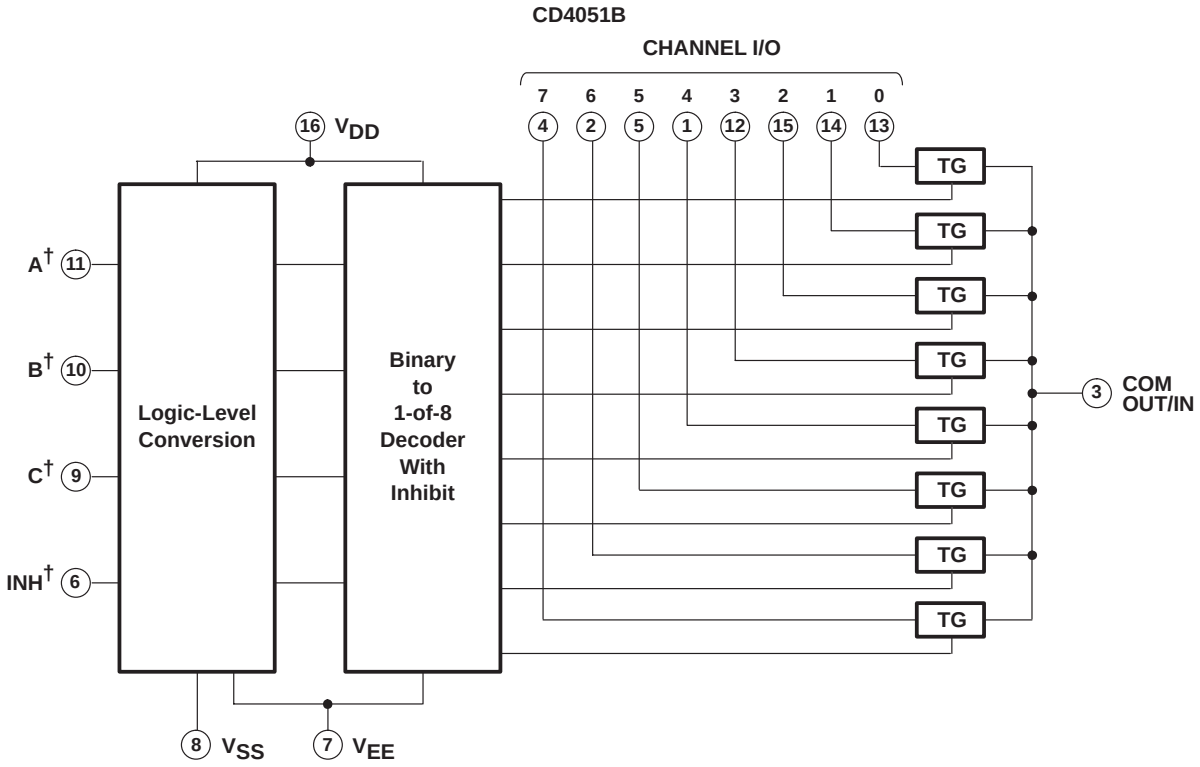
X = don’t care

CD4053

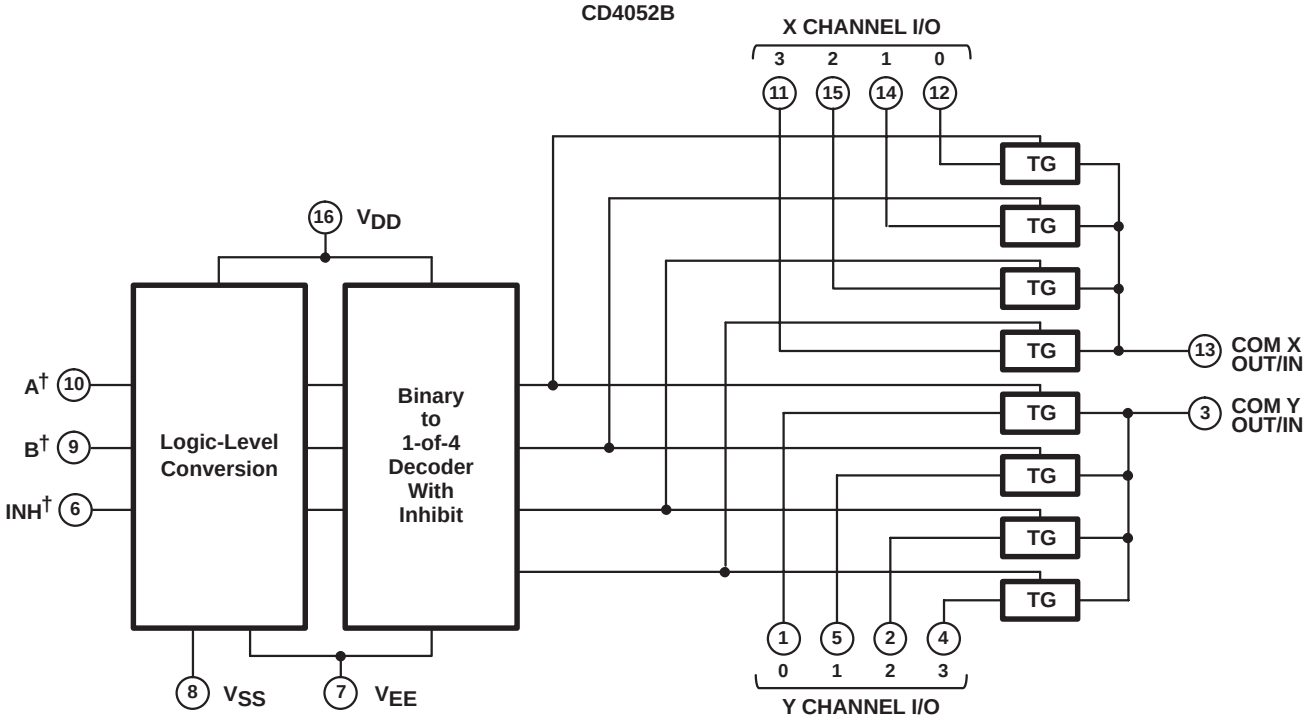
INPUTS		ON CHANNEL
INH	A OR B OR C	
L	L	ax or bx or cx
L	H	ay or by or cy
H	X	None

X = don’t care

logic diagram (positive logic)



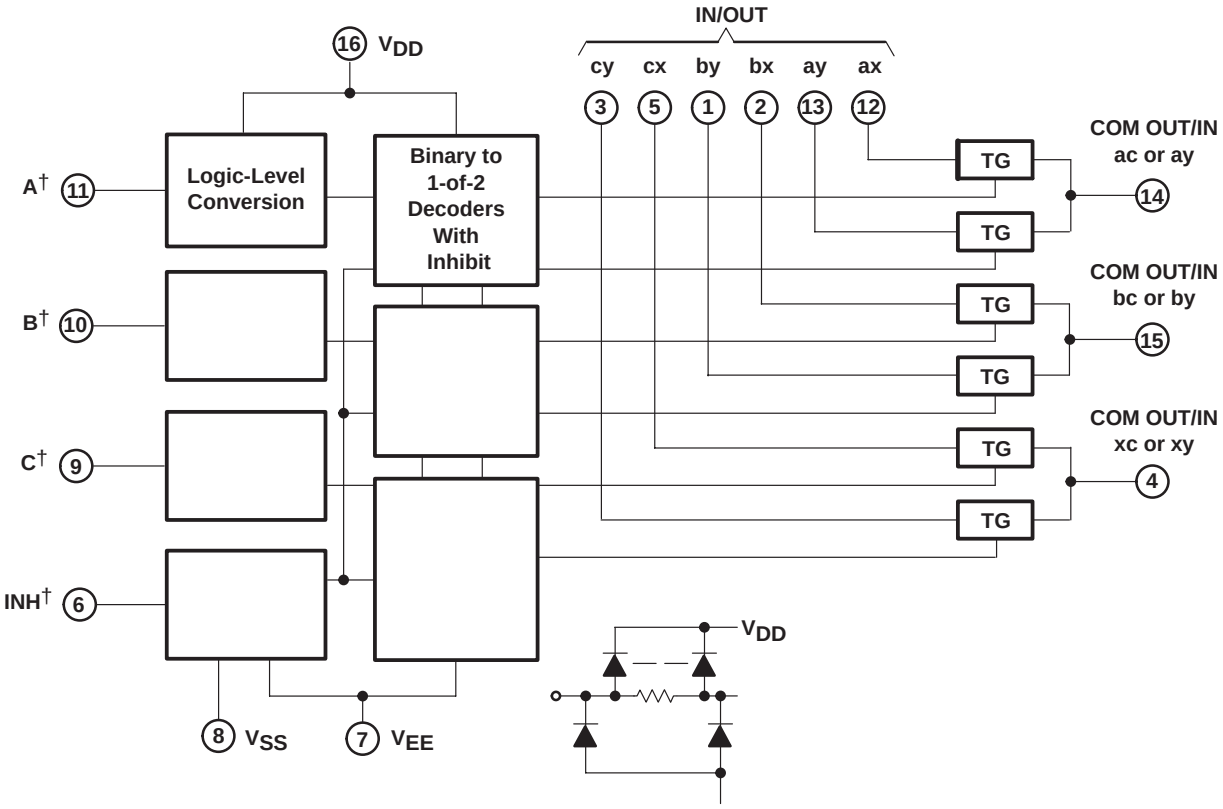
† All inputs are protected by CMOS protection network.



† All inputs are protected by CMOS protection network.

logic diagrams (positive logic) (continued)

CD4053B



† All inputs are protected by standard CMOS protection network.

absolute maximum ratings over operating free-air temperature (unless otherwise noted)‡

Supply voltage range, V+ to V− (voltages referenced to V_{SS} terminal) . . . . . −0.5 to 20 V
DC input voltage range . . . . . −0.5 V to V_{DD} + 0.5 V
DC input current, any one input . . . . . ±10 mA
Package thermal impedance, θ_{JA} (see Note 1): M package . . . . . 73°C/W
PW package . . . . . 108°C/W
Maximum junction temperature, T_J . . . . . 150°C
Lead temperature (during soldering):
At distance 1/16 ± 1/32 inch (1,59 ± 0,79 mm) from case for 10 s max . . . . . 265°C
Storage temperature range, T_{stg} . . . . . −65°C to 150°C

‡ Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions

		MIN	MAX	UNIT
V_{DD}	Supply voltage	5	20	V
T_A	Operating free-air temperature	−40	125	°C

electrical characteristics, $V_{SUPPLY} = \pm 5$ V, $A_V = 1$ V, $R_L = 100\ \Omega$, unless otherwise noted (see Note 2)

PARAMETER		TEST CONDITIONS		V_{DD} (V)	LIMITS AT INDICATED TEMPERATURES					UNIT
					−40°C	125°C	25°C			
							MIN	TYP	MAX	
I_{DD}	Quiescent device current			5	5	150		0.04	5	μA
				10	10	300		0.04	10	
				15	20	600		0.04	20	
				20	100	3000		0.08	100	
Signal Input (V_{IS}) and Output (V_{OS})										
r_{on}	Drain-to-source ON-state resistance	$V_{EE} = 0$ V, $V_{SS} = 0$ V, $V_{IS} = 0$ to V_{DD}		5	850	1300		470	1050	Ω
				10	330	550		180	400	
				15	210	320		125	240	
Δr_{on}	ON-state resistance difference between any two switches	$V_{EE} = 0$ V, $V_{SS} = 0$ V		5				15		Ω
				10				10		
				15				5		
	Input/output leakage current (switch off)	Any channel OFF (MAX) or all channels OFF (COM OUT/IN) (Max), $V_{EE} = 0$ V, $V_{SS} = 0$ V, See Note 3		18	±0.1	±1		$\pm 10^{-5}$	±0.1	μA
C_{is}	Input capacitance	$V_{EE} = -5$ V, $V_{SS} = -5$ V		5				5		pF
C_{os}	Output capacitance	$V_{EE} = -5$ V, $V_{SS} = -5$ V	CD4051	5				30		pF
			CD4052					18		
			CD4053					9		
C_{ios}	Feedthrough capacitance	$V_{EE} = -5$ V, $V_{SS} = -5$ V		5				0.2		pF
t_{pd}	Propagation delay (signal input to output)	$V_{IS(p-p)} = V_{DD}$, $R_L = 200$ kΩ, $C_L = 50$ pF, t_r, $t_f = 20$ ns		5				30	60	ns
				10				15	30	
				15				10	20	

NOTES: 2. Peak-to-peak voltage symmetrical about $\frac{V_{DD} - V_{EE}}{2}$

3. Determined by minimum feasible leakage measurement for automatic testing

electrical characteristics, V_{SUPPLY} = ±5 V, A_V = 1 V, R_L = 100 Ω, unless otherwise noted (see Note 2) (continued)

PARAMETER		TEST CONDITIONS	V_{EE} (V)	V_{DD} (V)	LIMITS AT INDICATED TEMPERATURES					UNIT
					−40°C	125°C	25°C			
							MIN	TYP	MAX	
Control (Address or Inhibit), V_C										
V_{IL}	Input low voltage	V_{IL} = V_{DD} through 1kΩ, V_{IH} = V_{DD} through 1kΩ, R_L = 1kΩ to V_{SS}, I_{is} < 2 μA on all OFF channels	V_{SS}	5	1.5	1.5			1.5	V
			V_{SS}	10	3	3			3	
			V_{SS}	15	4	4			4	
V_{IH}	Input high voltage	V_{IL} = V_{DD} through 1kΩ, V_{IH} = V_{DD} through 1kΩ, R_L = 1kΩ to V_{SS}, I_{is} < 2 μA on all OFF channels	V_{SS}	5	3.5	3.5	3.5			V
			V_{SS}	10	7	7	7			
			V_{SS}	15	11	11	11			
I_{IN}	Input current	V_{IN} = 0 V, 18 V		18	±0.1	±1		$±10^{-5}$	±0.1	μA
t_{pd1}	Address-to-signal OUT (channels ON or OFF) propagation delay	t_r, t_f = 20 ns, C_L = 50 pF, R_L = 10 kΩ, V_{SS} = 0 V, See Figure 10, Figure 11, and Figure 14	0	5				450	720	ns
			0	10				160	320	
			0	15				120	240	
			−5	5				225	450	
t_{pd2}	Inhibit-to-signal OUT (channel turning ON) propagation delay	t_r, t_f = 20 ns, C_L = 50 pF, R_L = 1 kΩ, V_{SS} = 0 V, See Figure 11	0	5				400	720	ns
			0	10				160	320	
			0	15				120	240	
			−10	5				200	400	
t_{pd3}	Inhibit-to-signal OUT (channel turning OFF) propagation delay	t_r, t_f = 20 ns, C_L = 50 pF, R_L = 10 kΩ, V_{SS} = 0 V, See Figure 15	0	5				200	450	ns
			0	10				90	210	
			0	15				70	160	
			−10	5				130	300	
C_{IN}	Input capacitance, any address or inhibit input							5	7.5	pF

NOTES: 2: Peak-to-peak voltage symmetrical about $\frac{V_{DD} - V_{EE}}{2}$

3: Determined by minimum feasible leakage measurement for automatic testing

electrical specifications

PARAMETER		TEST CONDITIONS		V_{IS} (V)	V_{DD} (V)	LIMITS AT INDICATED TEMPERATURES 25°C MIN	TYP	MAX	UNIT
	−3-dB cutoff frequency, channel ON (sine-wave input)	R_L = 1 kΩ, V_{OS} at COM OUT/IN, See Note 2, V_{OS} at COM OUT/IN	CD4053	5	10		30		MHz
			CD4052	5	10		25		
			CD4051	5	10		20		
		V_{EE} = V_{SS}, 20log V_{OS}/V_{IS} = −3 dB, V_{OS} at any channel					60		
THD	Total harmonic distortion	R_L = 10 kΩ, See Note 2		2	5		0.3		%
				3	10		0.2		
				5	15		0.12		
		V_{EE} = V_{SS}, f_{IS} = 1-kHz sine wave					0.12		
	−40-dB feedthrough frequency (all channels OFF)	R_L = 1 kΩ, V_{OS} at COM OUT/IN, See Note 2	CD4053	5	10		8		MHz
			CD4052	5	10		10		
			CD4051	5	10		12		
		V_{EE} = V_{SS}, 20log V_{OS}/V_{IS} = −40 dB, V_{OS} at any channel					8		
	−40-dB signal crosstalk frequency	R_L = 1 kΩ, between any two channels, See Note 2		5	10		3		MHz
		V_{EE} = V_{SS}, 20log V_{OS}/V_{IS} = −40 dB, Between sections, Measured on common	CD4052				6		
		V_{EE} = V_{SS}, 20log V_{OS}/V_{IS} = −40 dB, Between sections, Measured on any channel					10		
		V_{EE} = V_{SS}, 20log V_{OS}/V_{IS} = −40 dB, Between any two sections, In pin 2, Out pin 14	CD4053				2.5		
		V_{EE} = V_{SS}, 20log V_{OS}/V_{IS} = −40 dB, Between any two sections, In pin 15, Out pin 14					6		
	Address or inhibit to signal crosstalk	R_L = 10 kΩ, See Note 4			10		65		mV_{PEAK}
		V_{EE} = 0 V, V_{SS} = 0 V, t_r, t_f = 20 ns, V_{CC} = V_{DD} − V_{SS} (square wave)					65		

NOTES: 2. Peak-to-peak voltage symmetrical about $\frac{V_{DD} - V_{EE}}{2}$

4. Both ends of channel

TYPICAL CHARACTERISTICS

CHANNEL ON-STATE RESISTANCE
vs
INPUT SIGNAL VOLTAGE

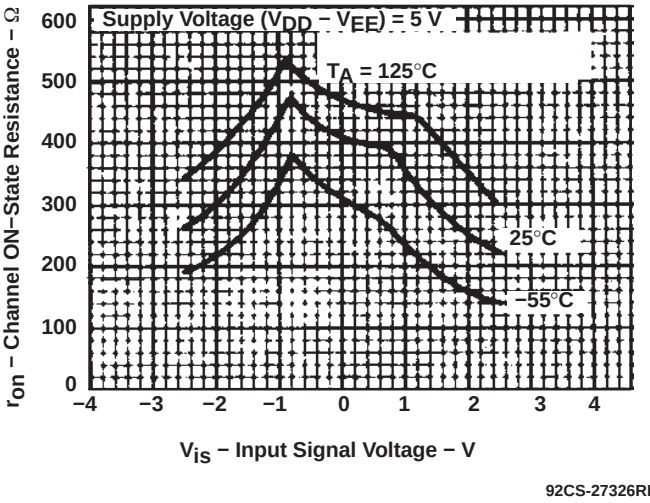


Figure 1

CHANNEL ON-STATE RESISTANCE
vs
INPUT SIGNAL VOLTAGE

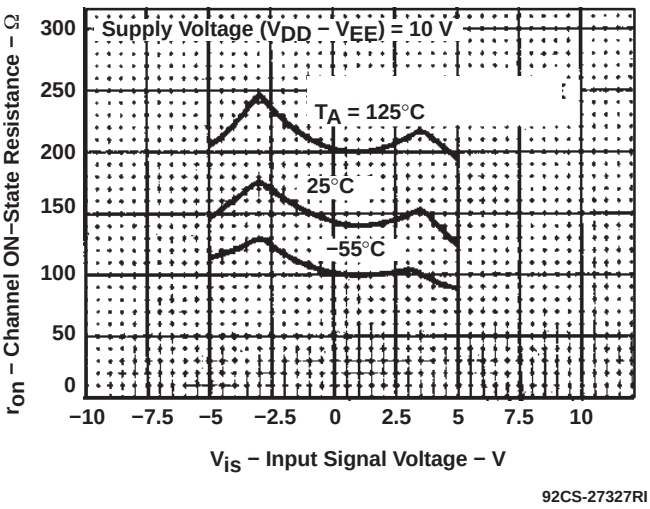


Figure 2

CHANNEL ON-STATE RESISTANCE
vs
INPUT SIGNAL VOLTAGE

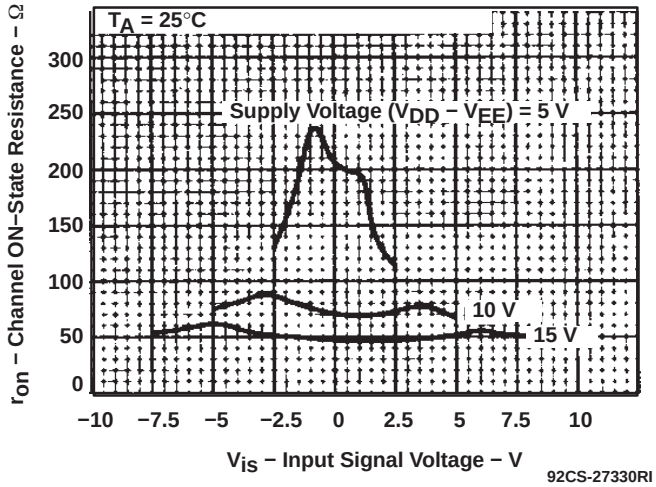


Figure 3

CHANNEL ON-STATE RESISTANCE
vs
INPUT SIGNAL VOLTAGE

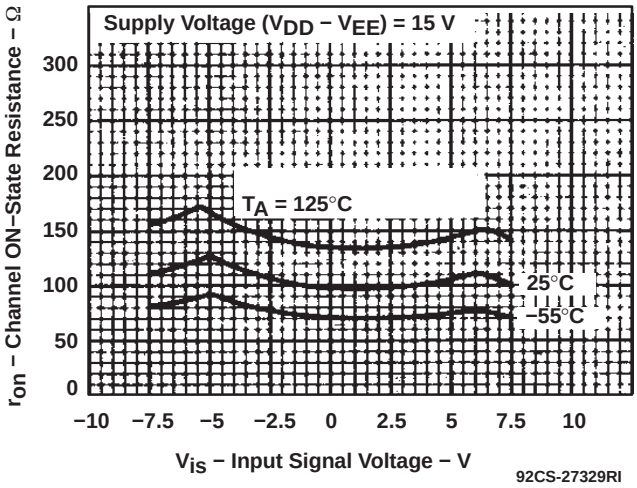


Figure 4

TYPICAL CHARACTERISTICS

ON CHARACTERISTICS FOR 1-OF-8 CHANNELS (CD4051B)

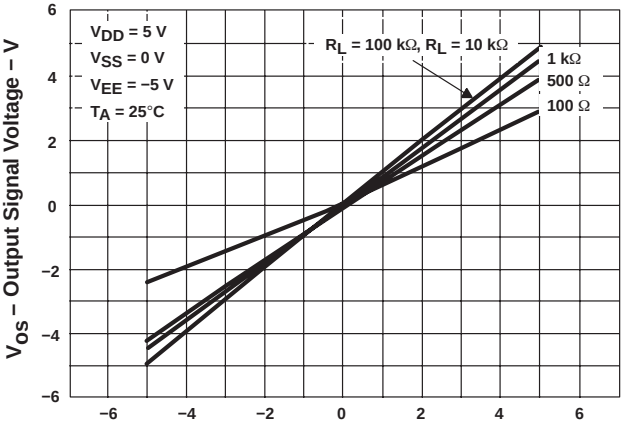


Figure 5

DYNAMIC POWER DISSIPATION vs SWITCHING FREQUENCY (CD4051B)

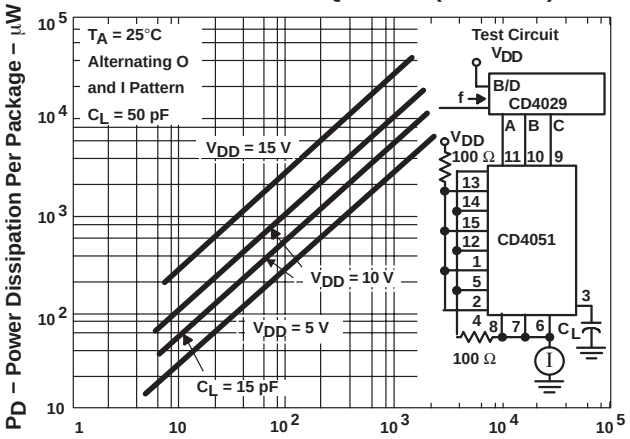


Figure 6

DYNAMIC POWER DISSIPATION vs SWITCHING FREQUENCY (CD4052B)

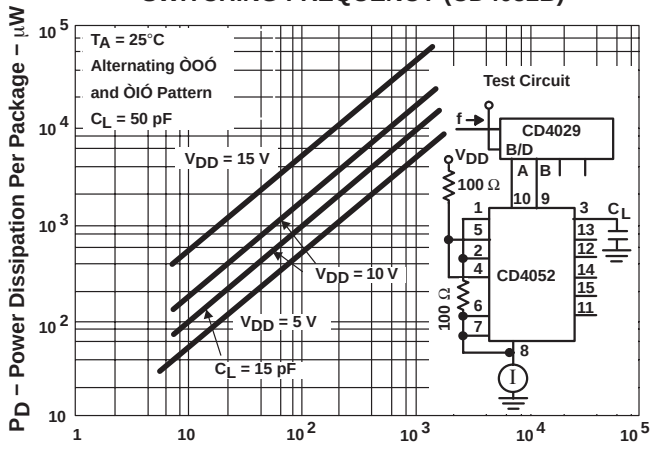


Figure 7

DYNAMIC POWER DISSIPATION vs SWITCHING FREQUENCY (CD4053B)

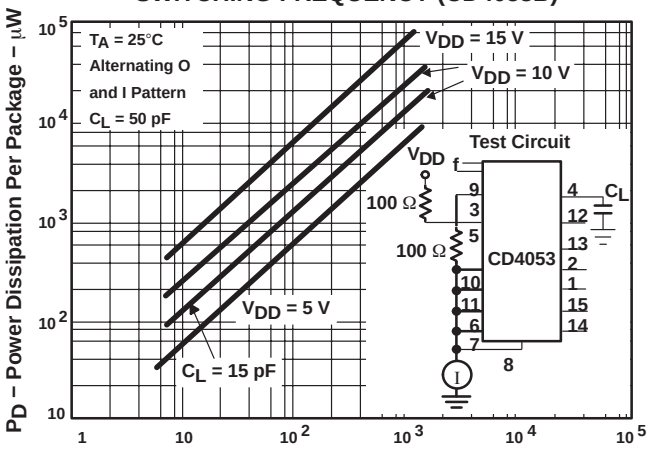
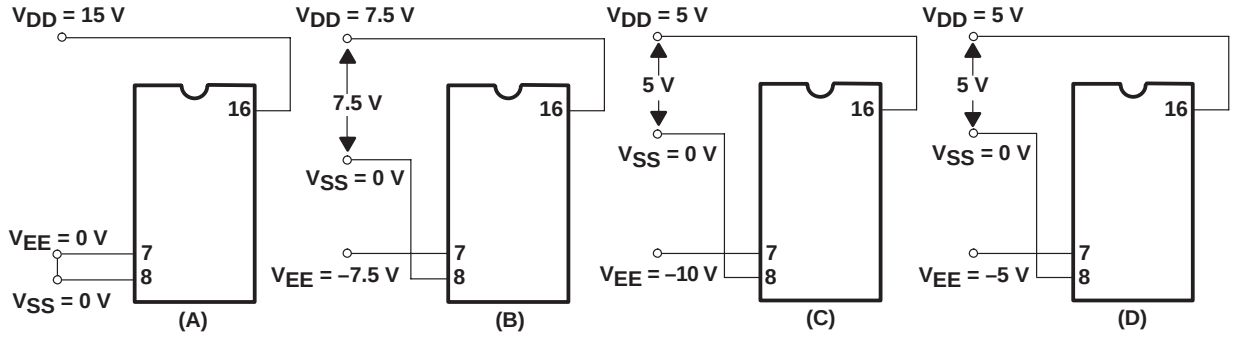


Figure 8

PARAMETER MEASUREMENT INFORMATION



NOTE: The A, B, C, and INH input logic levels are L = V_{SS} and H = V_{DD}. The analog signal (through the TG) may swing from V_{EE} to V_{DD}.

Figure 9. Typical Bias-Voltage Test Circuits

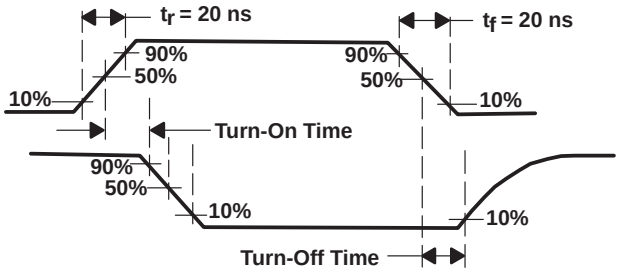


Figure 10. Channel Turned ON Waveforms (R_L = 1 kΩ)

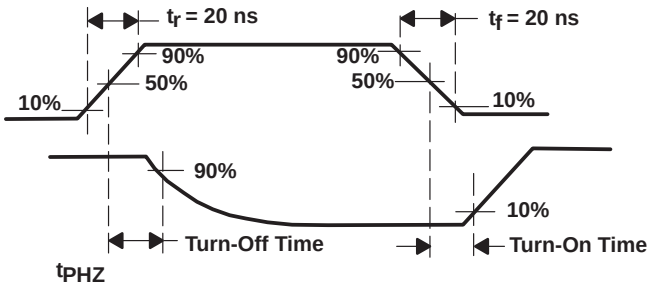


Figure 11. Channel Turned OFF Waveforms (R_L = 1 kΩ)

PARAMETER MEASUREMENT INFORMATION

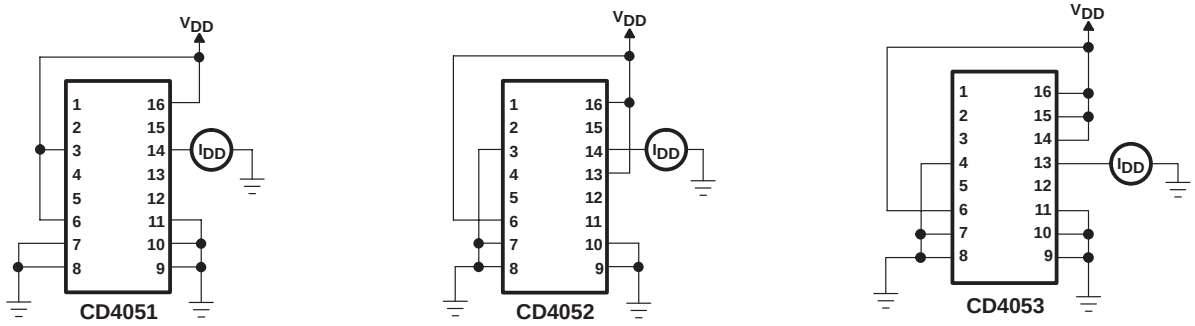


Figure 12. OFF Channel Leakage Current, Any Channel OFF

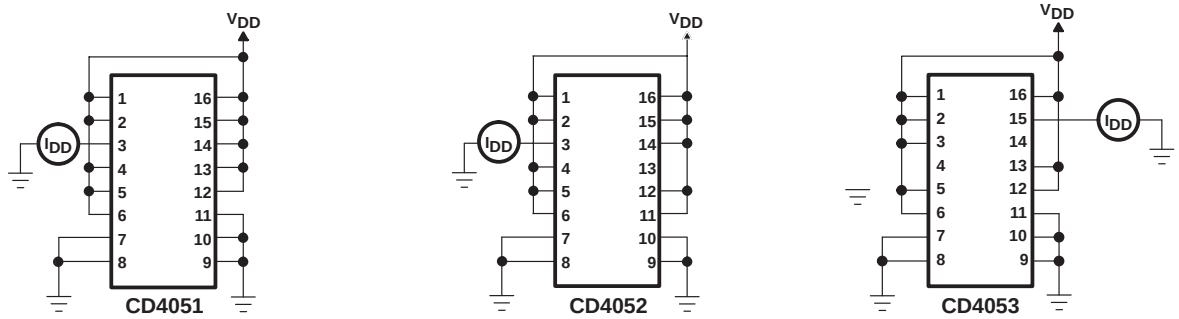


Figure 13. OFF Channel Leakage Current, All Channels OFF

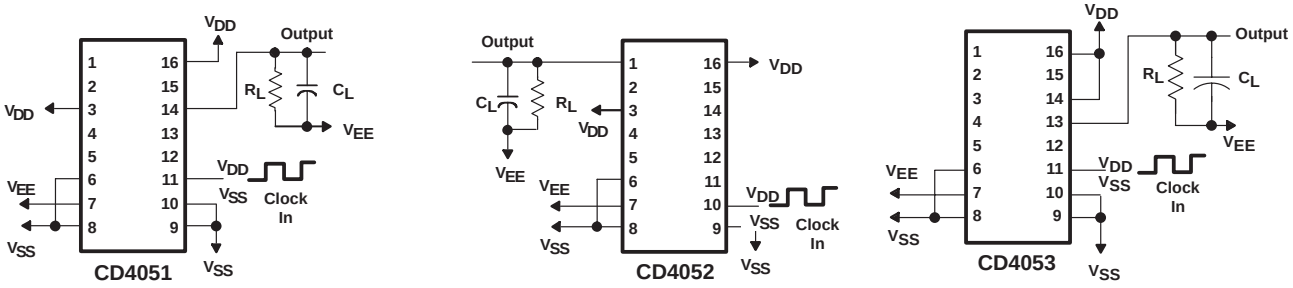


Figure 14. Propagation Delay, Address Input to Signal Output

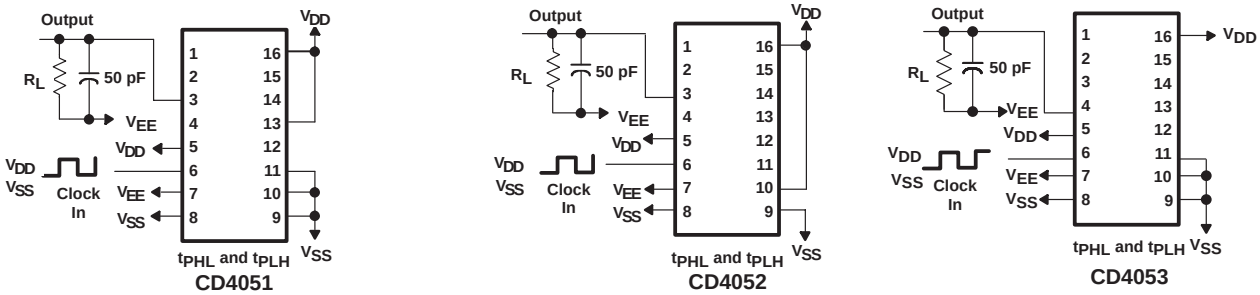


Figure 15. Propagation Delay, Inhibit Input to Signal Output

PARAMETER MEASUREMENT INFORMATION

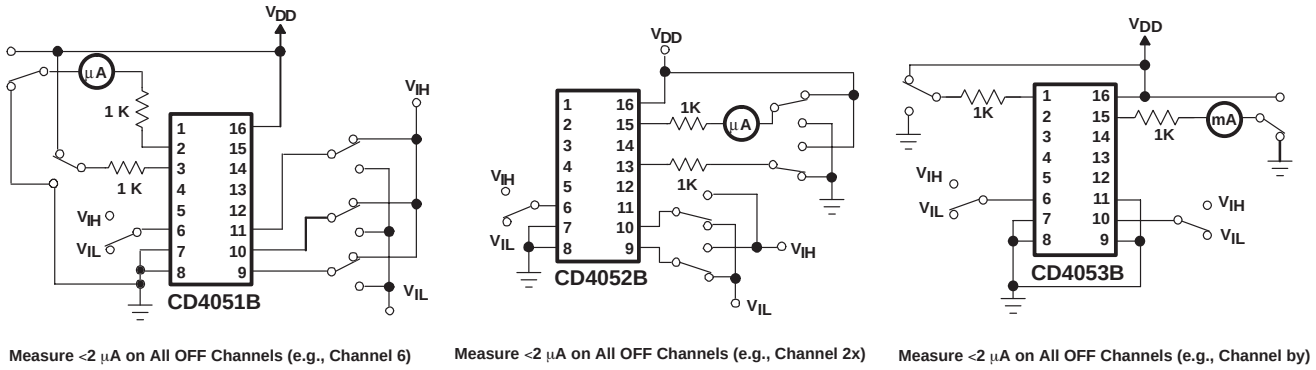


Figure 16. Input-Voltage Test Circuit (Noise Immunity)

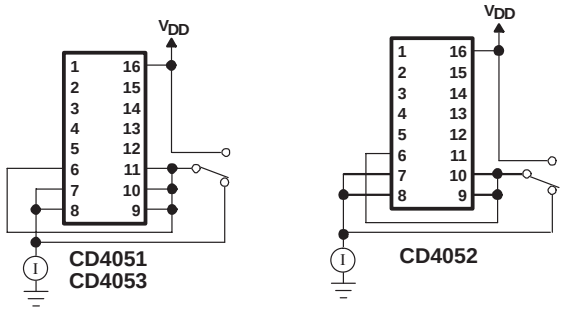


Figure 17. Quiescent Device Current

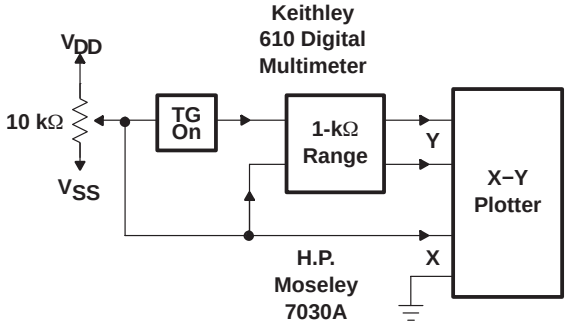
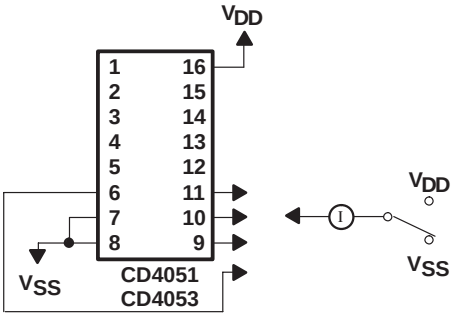
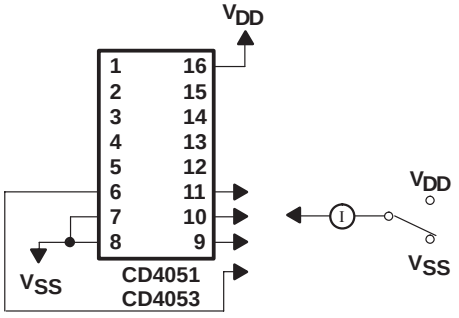


Figure 18. Channel ON-Resistance Test Circuit

PARAMETER MEASUREMENT INFORMATION



NOTE: Measure inputs sequentially to both V_{DD} and V_{SS}. Connect all unused inputs to either V_{DD} or V_{SS}.



NOTE: Measure inputs sequentially to both V_{DD} and V_{SS}. Connect all unused inputs to either V_{DD} or V_{SS}.

Figure 19. Input Current

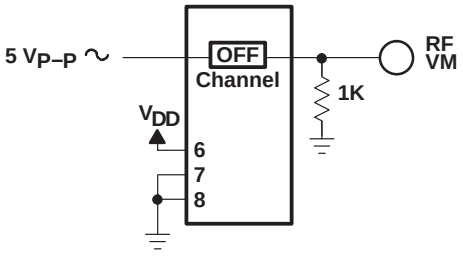


Figure 20. Feedthrough

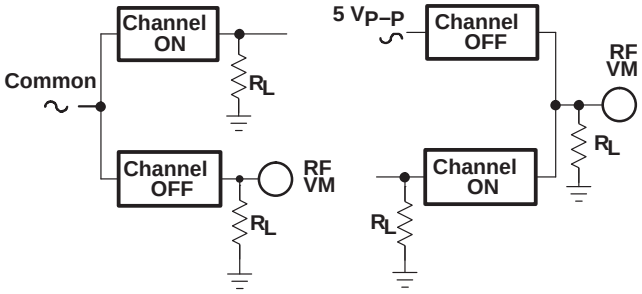


Figure 21. Crosstalk Between Any Two Channels

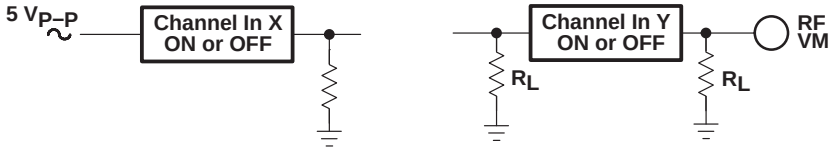


Figure 22. Crosstalk Between Duals or Triplets (CD4052B, CD4053B)

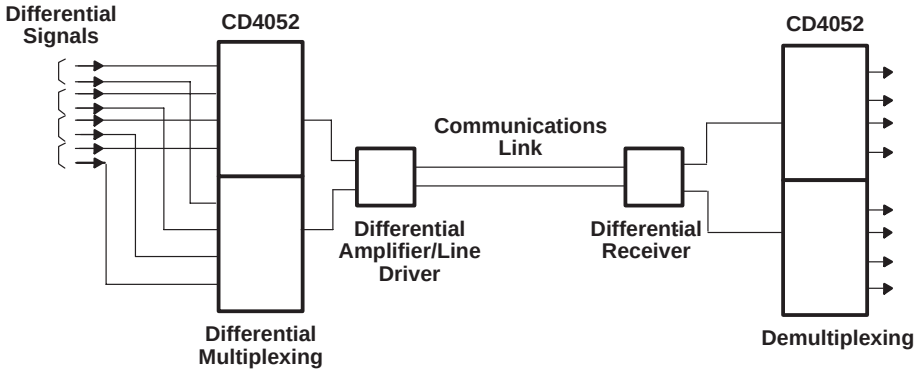


Figure 23. Typical Time-Division Application of the CD4052B

APPLICATION INFORMATION

In applications where separate power sources drive V_{DD} and the signal inputs, the V_{DD} current capability should exceed V_{DD}/R_L (R_L = effective external load). This provision avoids permanent current flow or clamp action on the V_{DD} supply when power is applied or removed from the CD4051B, CD4052B, or CD4053B.

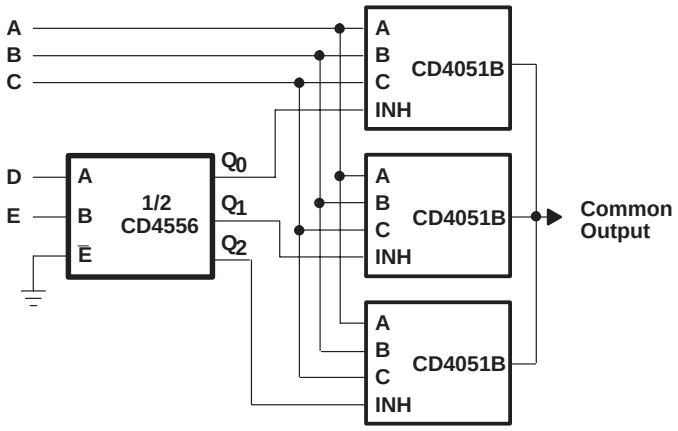
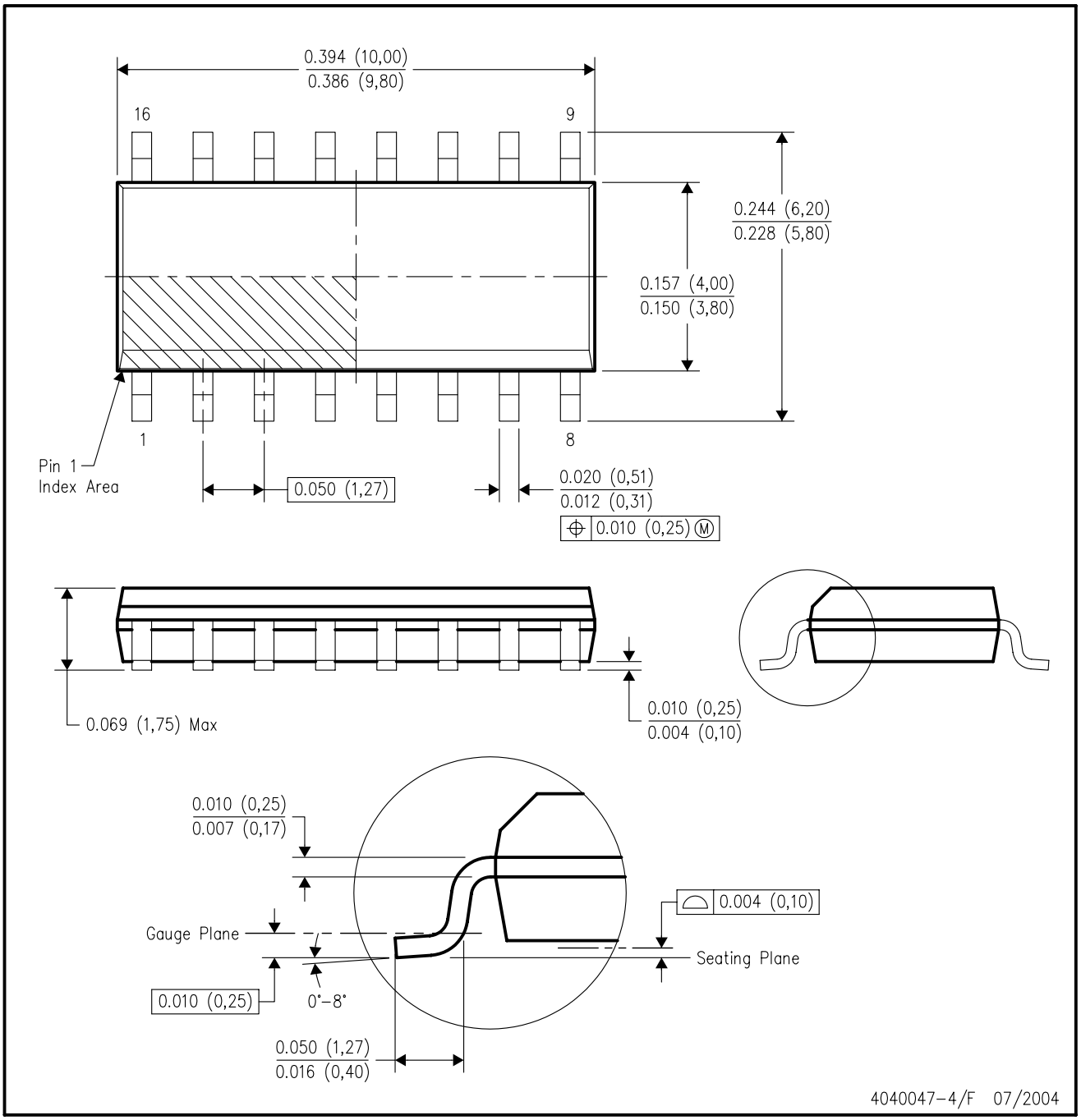


Figure 24. 24-to-1 Multiplexer Addressing

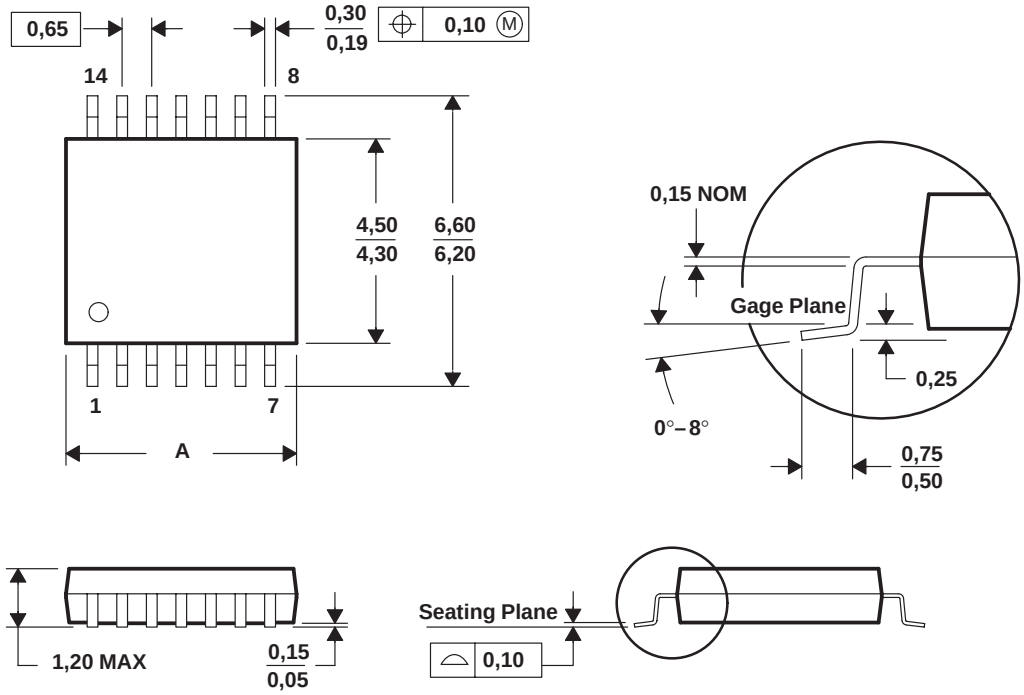
D (R–PDSO–G16) PLASTIC SMALL–OUTLINE PACKAGE



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
D. Falls within JEDEC MS–012 variation AC.

PW (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14 PINS SHOWN



DIM \ PINS **	8	14	16	20	24	28
A MAX	3,10	5,10	5,10	6,60	7,90	9,80
A MIN	2,90	4,90	4,90	6,40	7,70	9,60

4040064/F 01/97

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
D. Falls within JEDEC MO-153

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